Assessment of the effect of mouthpiece design on upper airway geometry using functional respiratory imaging

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Rationale
This study investigated the impact of mouthpiece design on the upper airway geometry. The influence of mouthpiece variation in height, width, protrusion and resistance to airflow were investigated by performing functional respiratory imaging. The designs were selected to represent those typically found in pressurized metered dose inhalers and dry powder inhalers.

Methods
12 healthy adult male subjects with a height between 175cm and 185cm and a normal BMI were included in the study. An incomplete Box-Behnken block design using 25 mouthpiece designs was used. Ultrafast spoiled gradient echo sequence MRI scans were taken with 11 different mouthpieces for each subject during tidal breathing. The upper airway was segmented and coupled with optically scanned dental impressions and computer aided design models of the mouthpieces (figure 1).

Results
Multiple regression analysis showed that protrusion had the largest positive effect on average cross sectional area and volume, followed by height. These effects were mainly steered by the
oral cavity. For the oropharynx, only the protrusion showed a small inverse correlation. None of the design parameters had an effect on the hypopharynx.

Conclusions
This study demonstrated that mouthpiece design can have an influence on the upper airway geometry.

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Figure

![Figure 1 Registration of the mouthpiece and teeth in the MRI image](image_url)